

WHAT IS CLAIMED IS:

1. A control apparatus for controlling a control system having a transfer function regarded as a second order system, comprising:

5 an outer loop configured to execute a negative-feedback of an output x of the controlled system to obtain a deviation e between the output x and a desired value r ;

10 a first inner loop configured to execute a negative-feedback of a signal $k_1 (dx/dt)$, obtained by multiplying a gain k_1 to a differentiated value (dx/dt) of the output x of the controlled system, to the deviation e ; and

15 a second inner loop configured to use the differentiated value (dx/dt) of the output x of the controlled system and a product, obtained by multiplying a gain k_2 to an absolute value $|e|$ of the deviation e or n powers (n : integer) of the absolute value $|e|$, to execute the positive feedback of a signal
20 of $k_2(dx/dt) \cdot |e|$ or $k_2(dx/dt) \cdot |e|^n$ to the deviation e ,

wherein the controlled system is controlled using a signal which is fed back through the first and the second inner loops.

25 2. A control apparatus according to claim 1, wherein, when the controlled system includes a position control model, an adjusting element which changes the gain k_2 to $c / |r|$ or $c / |r|^n$ based on the desired value

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r is provided.

3. A control apparatus according to claim 1,
wherein a loop gain is inserted in the outer loop,
when the controlled system has a transfer function with
5 a proportional gain.

4. A control apparatus according to claim 1,
wherein the gains k_1 and k_2 are set to values meeting
the following equation of damping coefficients of
a control system which are zero and positive:
10 $J + k_1 - k_2 |r| \geq 0$ or $J + k_1 - k_2 |r|^n \geq 0$, where J is
a constant determined due to the controlled system with
a secondary delay.

5. A control apparatus according to claim 4,
wherein, when the controlled system is a position
15 control model, an adjusting element which changes
the gain k_2 to $c/|r|$ or $c/|r|^n$ based on the desired value
r is provided.

6. A control apparatus according to claim 4,
wherein, when the controlled system has a transfer
20 function including a proportional gain, a loop gain is
inserted in the outer loop.

7. A control apparatus comprising:
an outer feedback loop which performs negative
feedback of an output from a controlled system;
25 a deviation computing unit which computes a
deviation between a desired value and a controlled
variable or output of the outer feedback loop;

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a first inner feedback loop which performs negative feedback of a product of a differential value of the controlled variable or speed and a gain;

5 a compensation unit which performs processing for canceling the deviation from the deviation computing unit by a compensation signal from the first inner feedback loop; and

10 a second inner feedback loop which changes a damping coefficient of a control system according to the deviation from the deviation computing unit.

8. A control apparatus according to claim 7, wherein the controlled system includes a gain K , and the outer feedback loop includes a gain computing element which multiplies the output of the controlled system by a loop gain K_f to perform feedback of the product.

9. A control apparatus according to claim 7, wherein the second inner feedback loop comprises a laplace operator which outputs a differential value of a controlled variable or speed of the controlled system, an absolute value computing element which computes an absolute value of the deviation obtained from the deviation computing element or n -th ($n=1, 2, 3, \dots$) power of the absolute value, a gain computing element which multiplies the computation output of the absolute value computing element with another gain, and a positive feedback element which performs positive

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feedback of a product of the output of the gain computing element and a differential value of the controlled variable or speed to the compensation element.

5 10. A control apparatus according to claim 9,
wherein the controlled system includes a gain K, and
the outer feedback loop includes a gain computing
element which multiplies the output of the controlled
system by a loop gain K_f to perform feedback of the
10 product.

 11. A control apparatus according to claim 7,
wherein the first inner feedback loop comprises a
computing element having a laplace operator which takes
out a differential output of the controlled variable or
15 output of the controlled system, and a gain computing
element which multiplies the differential output from
the computing element by the gain to obtain the
product.

 12. A control apparatus according to claim 11,
20 wherein the controlled system includes a gain K, and
the outer feedback loop includes a gain computing
element which multiplies the output of the controlled
system by a loop gain K_f to perform feedback of the
product.

25 13. A control apparatus according to claim 11,
wherein the second inner feedback loop comprises a
laplace operator which outputs a differential value of

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a controlled variable or speed of the controlled system, an absolute value computing element which computes an absolute value of the deviation obtained from the deviation computing element or n -th ($n=1, 2, 3, \dots$) power of the absolute value, a gain computing element which multiplies the computation output of the absolute value computing element with another gain, and a positive feedback element which performs positive feedback of a product of the output of the gain computing element and a differential value of the controlled variable or speed to the compensation element.

14. A control apparatus according to claim 13, wherein the controlled system includes a gain K , and the outer feedback loop includes a gain computing element which multiplies the output of the controlled system by a loop gain K_f to perform feedback of the product.

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